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Smart Attendance Using Machine Learning

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Abstract:

The proposed Smart Attendance System aims to revolutionize traditional attendance management methods by leveraging the Inception v3 model and Haar Cascade Algorithm for efficient and accurate attendance tracking. By utilizing machine learning-based object detection techniques, the system can detect faces from images captured by a camera in real-time. Once faces are detected, facial recognition algorithms are applied to match them with a pre-existing database of authorized individuals, enabling accurate identification and recording of attendance. This approach eliminates the need for manual intervention, minimizing errors associated with entering the data manually. Overall, the implementation of this system promises to streamline attendance management processes, improve efficiency, and ensure accountability across various institutions and sectors.

***Keywords* - Smart Attendance, Inception v3, Haar Cascade Classifier, Machine Learning**

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I. INTRODUCTION

The importance of attendance management systems in institutions is underscored, alongside the limitations of conventional methods. It introduces the Smart Attendance System as a solution, employing the Haar Cascade Algorithm for automated attendance tracking. The algorithm's effectiveness in object detection, particularly in recognizing faces, is highlighted as a key feature. The advantages of the Smart Attendance System include its ability to accurately identify individuals without manual intervention, real-time monitoring capabilities, and robust security measures. Through the integration of facial recognition algorithms and encryption techniques, sensitive attendance data is safeguarded.

Inception v3 is a deep learning model. It's a convolutional neural network (CNN) architecture that consists of multiple layers, allowing it to learn complex patterns and features from input images. Inception v3 is known for its efficiency and accuracy in image recognition tasks. Inception V3 employs a deep network with multiple layers and utilizes various types of convolutional filters, including 1x1, 3x3, and 5x5 convolutions, as well as pooling operations, to capture features at different scales. It's widely used in computer vision tasks such as image classification, object detection, and attendance tracking.

Inception v3 consists of various layers, including :

1.Convolutional Layers: These layers apply convolution operations to input images, extracting features at different spatial scales.

2. Pooling Layers: Pooling layers reduce the spatial dimensions of the feature maps, helping to decrease computational complexity and control overfitting.

3. Inception Modules: These are the key components of the Inception architecture. Inception modules use parallel convolutional operations with different kernel sizes to capture features at multiple scales efficiently.

4. Fully Connected Layers: These layers are typically found at the end of the network and perform classification based on the features extracted by earlier layers.

5. Auxiliary Classifiers: Inception v3 includes auxiliary classifiers inserted at intermediate layers during training to aid in gradient propagation and regularization.

Each layer type contributes to the model's ability to learn hierarchical representations of the input data and perform accurate image classification.

The Inception v3 model along with a Haar cascade classifier for face attendance has its advantages over using the MTCNN (Multi-task Cascaded Convolutional Networks) model. Here are some advantages:

- Speed: Inception v3 is generally faster than MTCNN. The architecture of Inception v3 allows for quicker inference times compared to MTCNN, making it more suitable for real-time applications like face attendance systems.
- Resource Efficiency: Inception v3 is less resource-intensive compared to MTCNN. This means it can run efficiently on devices with limited computational resources, making it a practical choice for deployment on various platforms.
- Pre-trained Model Availability: Inception v3 models are readily available and pre-trained on large datasets like ImageNet. This availability makes it easier to implement and fine-tune for specific tasks like face recognition or detection.
- Accuracy: While MTCNN is known for its high accuracy in detecting faces under various conditions (e.g., different poses, lighting conditions, occlusions), Inception v3 can also achieve reasonably good accuracy for face detection tasks. With proper training and tuning, Inception v3 can provide satisfactory performance for face attendance systems.
- Integration: Inception v3 can be seamlessly integrated with other deep learning models or traditional computer vision techniques like Haar cascade classifiers, providing flexibility in system design and optimization.

The retrain.py script, often used in TensorFlow's image classification tutorial, is a script for retraining a pre-trained image classification model, such as Inception v3, on a new dataset. The parameters used in this script may include:
1. --image_dir: Specifies the directory containing the training images.

2. --output_graph: Specifies the file path to save the retrained model graph.

3. --output_labels: Specifies the file path to save the labels file.

4. --summaries_dir: Specifies the directory to save TensorFlow summary data for visualization.

5. --how_many_training_steps: Specifies the number of training steps to perform.

6. --learning_rate: Specifies the learning rate for training.

7. --testing_percentage: Specifies the percentage of images to use for testing.

8. --validation_percentage: Specifies the percentage of images to use for validation.

9. --train_batch_size: Specifies the batch size for training.

10. --validation_batch_size: Specifies the batch size for validation.

11. --testing_batch_size: Specifies the batch size for testing.

12. --bottleneck_dir: Specifies the directory to cache the bottleneck features.

13. --final_tensor_name: Specifies the name of the final output tensor in the retrained model.

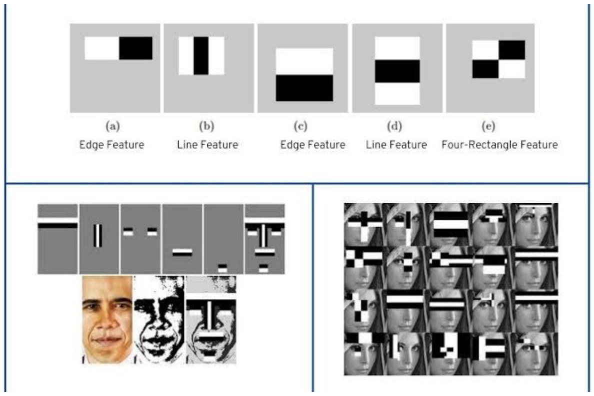
14.--flip_left_right,--random_crop,--random_scale,
--random_brightness:Specifies data augmentation techniques.

15. --architecture: Specifies the pre-trained model architecture, such as 'inception_v3', 'mobilenet_1.0_224', etc.

These parameters control various aspects of the retraining process, such as input data preprocessing, model architecture, training hyperparameters, and output file paths.

Harr Cascade classifier is used in preprocessing as it is known for simplicity and speed in face detection tasks, and Inception v3 is favored for its accuracy and versatility in complex image classification. Haar Cascade can be harnessed for image recognition by training a cascade classifier to identify specific objects or patterns within images. This process begins with dataset preparation, where positive examples containing the target object and negative examples without it are compiled. Haar-like features, which describe the contrast between neighboring regions within an image, are then extracted from these examples. The cascade classifier learns to distinguish between positive and negative instances based on the presence or absence of these features. Through training using machine learning techniques, the classifier gradually improves its ability to recognize the desired object or pattern by iteratively selecting and combining the most discriminative Haar-like features. Subsequently, the trained classifier is tested on new images to evaluate its performance. Employing a sliding window approach, it scans the faces, searching for regions matching the learned features. When a match is detected, the classifier identifies the region as containing the object or pattern being recognized. Finally, the trained Haar Cascade classifier can be integrated into an face recognition system, enabling automatic detection and recognition of the target object or pattern in new faces.

In image recognition, line and edge features serve as key elements for capturing and interpreting the spatial structure and boundaries of objects. Line features entail the identification of straight or curved lines within an image, representing the contours or boundaries of objects or structures. These lines, which can vary in orientation and thickness, play a crucial role in delineating the overall shape and relationships between different parts of the object. On the other hand, edge features detect abrupt changes in pixel intensity, typically occurring at boundaries between distinct regions or objects. These changes manifest as strong gradients in pixel intensity, indicating transitions from light to dark or vice versa. In image recognition, the combination of line and edge features provides vital cues for distinguishing between different objects and forms the basis for various algorithms and methodologies employed to extract meaningful information from images for classification, detection, and other purposes.



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II. LITERATURE SURVEY

The study conducted by [1] introduces a revolutionary approach to attendance tracking by leveraging facial recognition technology. Unlike traditional methods like RFID cards or biometric scanners, this system harnesses the power of Convolutional Neural Networks (CNNs) to achieve an impressive 98% recognition rate.

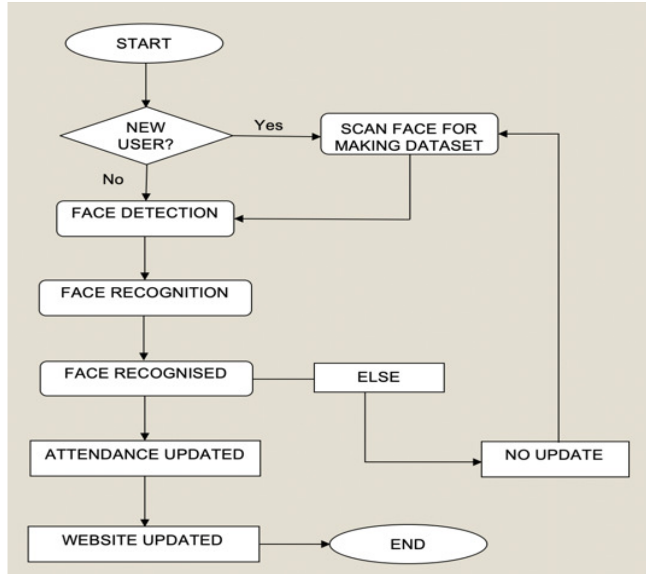
The study conducted [2] proposes a face identification and attendance system using CNNs, reducing the tediousness of manual attendance processes in academic institutions. The system, incorporating MTCNN and Face Net modules, claims robustness achieving a real-time accuracy of 96.02% against challenges like varying lightning conditions and occlusion.

The study outlined in [3] introduces a cutting-edge Real-Time Smart Attendance System designed specifically for classroom settings. By employing advanced Face Recognition Techniques such as Eigenface values, PCA, and CNN, the system addresses the shortcomings of both manual and automated attendance tracking methods. Its primary goal is to provide a secure and efficient solution that not only streamlines attendance processes in educational institutions but also holds potential for broader applications in multinational companies and banks.

The study conducted [4] presents an innovative End-to-End Real-Time Face Identification and Attendance System that leverages CNNs, MTCNN, and Face Net modules to automate attendance procedures within academic environments. With a commendable real-time accuracy rate of 96%, the system effectively analyzes CCTV footage or class videos, enabling swift attendance marking for entire classes in a single instance. While surpassing the performance of existing systems, certain limitations arise, particularly concerning distant faces and low-resolution videos. This suggests the potential for future enhancements, such as incorporating super-resolution modules.

The research paper [5] presents an automated Attendance System based on Face Recognition, utilizing the Local Binary Pattern (LBP) technique. The system is designed to tackle challenges associated with conventional attendance methods by integrating the Viola-Jones algorithm for face detection and LBP for recognition. By capturing students' faces in real-time, it facilitates quicker and more precise attendance recording, thereby eliminating the necessity for manual signatures.

III. FLOW OF PROJECT



IV. METHODOLOGY

1. Data Collection

In order to use the attendance system, students are required to register by entering their names and having their images captured. These images are then stored in a dedicated dataset folder (**Fig 1.2**). The current data set consists of 11 students.Dataset is created by clicking on the take images button on the interface. In the application you enter your details which being name and roll no which is stored inside the StudentDetails folder in csv format. As soon as you click on the 'Take Images' button a cv2 window pops up in order to capture your aface. Then it captures your image and takes 7 images per person and stores inside the TrainingImage folder in grey scale format so that it becomes easier to analyze the intensity differences on our faces.Inside the TrainingImage folder, your images i.e. 7 per person is stored with your name and roll no as given in the StudentDetails folder.

2.Face Detection

The system performs face detection after training(**Fig 1.4**). and testing **(Fig 1.3)**.the images using OpenCV and Harr Cascade Algorithm.

3.Face Recognition:
After cropping the face from the captured images, the system employs face embedding to extract distinctive features.
4. Feature Extraction:

After cropping the face from the captured images, the system employs face embedding to extract distinctive features.

5. Updating Attendance

It will match the face with the datasets and if present will update their attendance and mark them as present (Fig 1.6)along with their name ,date and time when attendance was marked and store the data in an Excel Sheet.(Fig 1.5)

6.View the attendance on website

The excel sheet generated is directly uploaded on the college website(Fig 1.7) which grants access to the students, teachers as well as the parents(Fig 1.9).

V. RESULTS

The implementation of our smart attendance system, powered by machine learning algorithms, has yielded notable results in revolutionizing the traditional attendance management process. Through the integration of sophisticated techniques, our system has significantly streamlined the attendance tracking workflow. By automating various tasks, such as data collection, face detection, recognition, feature extraction, and attendance updating, the system minimizes manual intervention, thereby saving time for both students and faculty.

One of the standout achievements of our system is its remarkable accuracy in identifying students and marking their attendance, thanks to the advanced face detection and recognition algorithms employed. This high level of accuracy minimizes errors and ensures reliable attendance records. Moreover, the accessibility of attendance data has been greatly enhanced through seamless integration with the college website, allowing stakeholders such as students, teachers, and parents to monitor attendance trends remotely and in real-time.

Additionally, the scalability of our system enables it to effortlessly handle large datasets and accommodate the evolving needs of educational institutions of varying sizes.

Overall, our smart attendance system represents a significant advancement in attendance management, offering a reliable, accurate, and accessible solution that contributes to improved efficiency and productivity within educational environments.

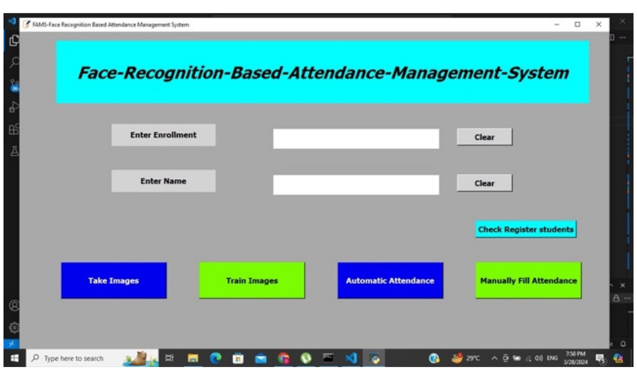


Fig 1.1 Opening page of the smart attendance system

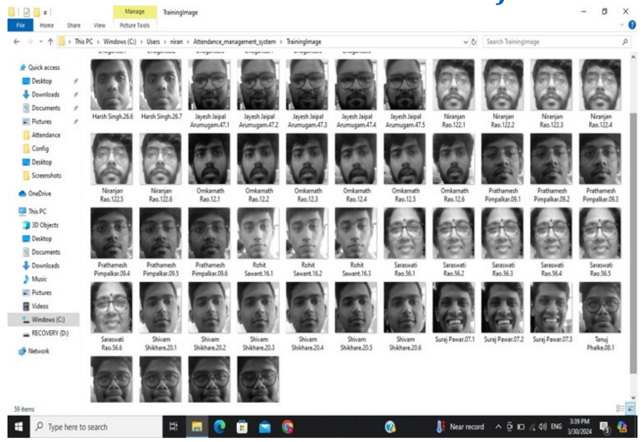


Fig 1.2 These are the datasets created which consists of at least 6-7 images per student which are further used for identification.

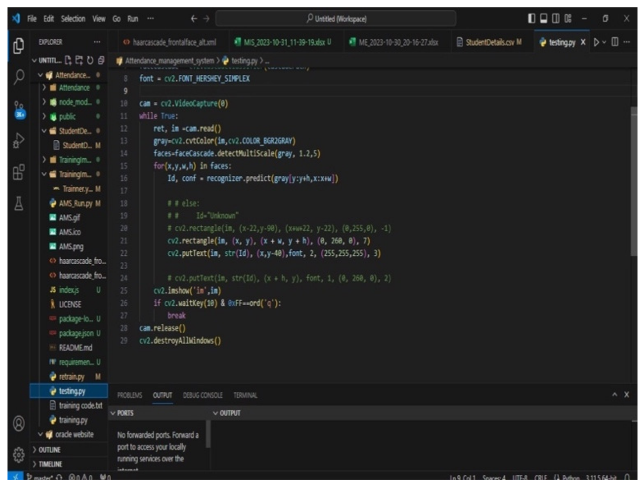


Fig 1.3 Testing phase which denotes the algorithm uses width, height, x and y axis

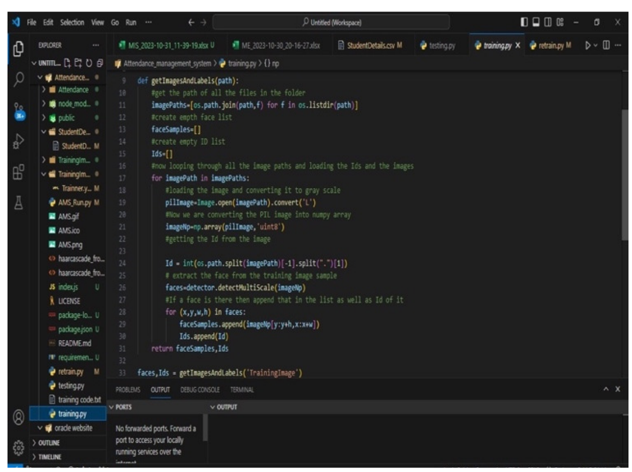


Fig 1.4 Training phase in which the images are trained accompanied by extraction of features from the image.

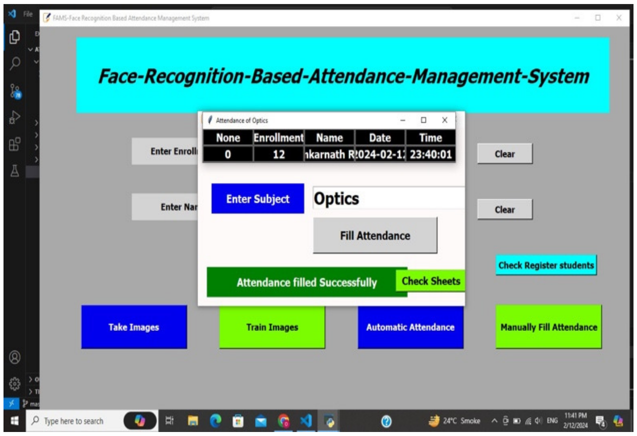


Fig 1.5 The attendance is marked along with the name, date and time for the particular subject.

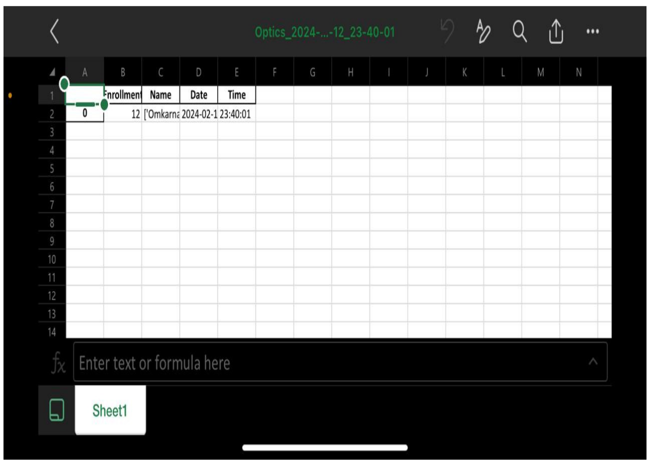


Fig 1.6 The creation of the excel sheet of the particular Subject

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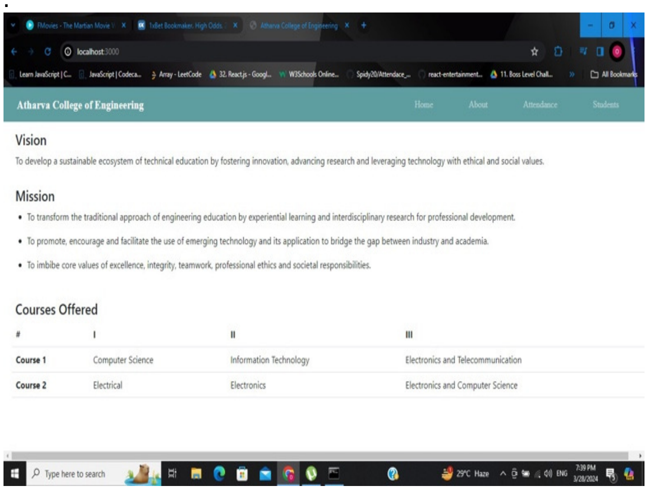

Fig 1.7A model website of the institution is created for accessing the attendance records.

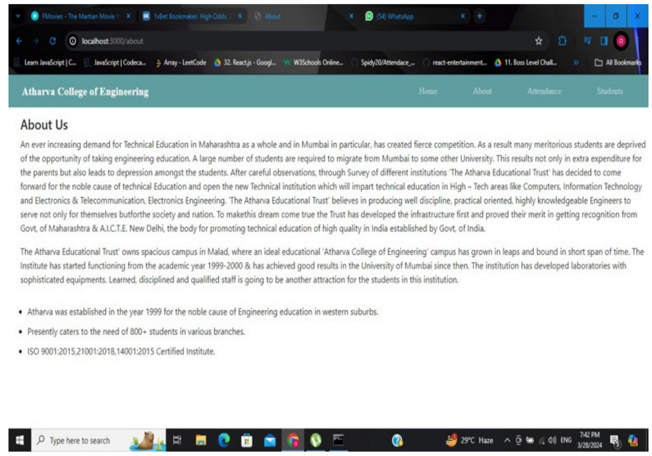

Fig 1.8 Website shows information of the institute

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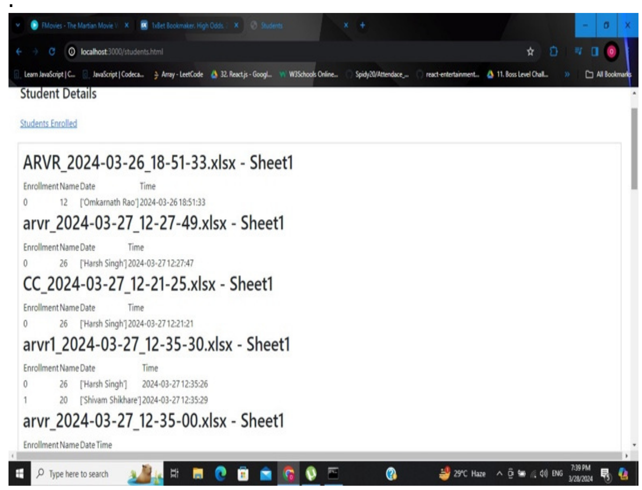

Fig 1.9 The attendance records are updated directly in the website.

VI. ACCURACY TABLE:

To calculate the overall accuracy, you can sum up the accuracies for each prediction and then divide by the total number of samples. Total Correct Predictions = 1 (Anshul Unagar) + 1 (ShivamShikhare) + 1 (Harsh Singh) + 1 (Omkarnath Rao) + 0.66 (TanujPhalke) + 1 (PrathameshPimpalkar) + 1 (Suraj Pawar) + 1 (Rohit Sawant) + 1 (Niranjan Rao) + 1 (Jayesh Jaipal) + 1 (Saraswati Rao) = 10 Total Samples = 11 Overall Accuracy = Total Correct Predictions / Total Samples = 10.66 / 11 ≈ 0.969

So, the overall accuracy is approximately 96.9%.

VII. CONCLUSION

In conclusion, the development and implementation of a Smart Attendance System represent a significant advancement in the realm of attendance tracking. By integrating machine learning techniques such as Haar Cascade, OpenCV, and possibly Inception v3, this system offers automated, accurate, and real-time monitoring of attendance across diverse settings, from educational institutions to corporate environments. Through the efficient utilization of these technologies, the Smart Attendance System streamlines administrative processes, enhances accountability, and reduces errors associated with manual attendance tracking methods. Moreover, its adaptability, scalability, and compatibility with existing infrastructure ensure seamless integration into various organizational contexts. As technology continues to evolve, the Smart Attendance System stands as a testament to the potential of innovative solutions to address traditional challenges, paving the way for enhanced efficiency, productivity, and transparency in attendance management.

ID	Ground Truth	Predicted Label 1	Predicted Label 2	Predicted Label 3	Percentage
1	Anshul Unagar	Anshul Unagar	Anshul Unagar	Anshul Unagar	1.0
2	ShivamShikhare	ShivamShikhare	ShivamShikhare	ShivamShikhare	1.0
3	Harsh Singh	Harsh Singh	Harsh Singh	Harsh Singh	1.0
4	Omkarnath Rao	Omkarnath Rao	Omkarnath Rao	Omkarnath Rao	1.0
5	TanujPhalke	TanujPhalke	Jayesh Jaipal	TanujPhalke	0.66
6	Prathamesh	Prathamesh	Prathamesh	Prathamesh	1.0
7	Suraj Pawar	Suraj Pawar	Suraj Pawar	Suraj Pawar	1.0
8	Rohit Sawant	Rohit Sawant	Rohit Sawant	Rohit Sawant	1.0
9	Niranjan Rao	Niranjan Rao	Niranjan Rao	Niranjan Rao	1.0
10	Jayesh Jaipal	Jayesh Jaipal	Jayesh Jaipal	Jayesh Jaipal	1.0
11	Saraswati Rao	Saraswati Rao	Saraswati Rao	Saraswati Rao	1.0

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